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Low Cost Housing through Prefabrication

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Abstract- This paper aims to point out the various aspects of prefabricated building methodologies for low cost housing by highlighting the different prefabrication techniques, and the economical advantages achieved by its adoption.

Keywords- *Prefabrication, Precast RCC 'kular', precast joist, Ferro cement products.*

1. Introduction

Affordable housing is a term used to describe dwelling units whose total housing cost are deemed "Affordable" to a group of people within a specified income range. In India, the technology to be adopted for housing components should be such that the production and erection technology be adjusted to suite the level of skills and handling facilities available under metropolitan, urban and rural conditions. Logical approach for optimizing housing solutions: There should be a logical approach for providing appropriate technology based on the availability of options, considering its technical and economical analysis.

1. There should be optimal space in the design considering efficiency of space, minimum circulation space.
2. Economy should be considered in design of individual buildings, layouts, clusters etc.
3. While preparing the specifications it should be kept in mind that, cost effective construction systems are adopted.
4. To develop an effective mechanism for providing appropriate technology based shelter particularly to the vulnerable group and economically weaker section.

Prefabrication as applied to `Low Cost Housing Advantages of prefabrication are: In prefabricated construction, as the components are readymade, self supporting, shuttering and scaffolding is eliminated with a saving in shuttering cost. In precast construction, similar types of components are produced repeatedly, resulting in increased productivity and economy in cost too. Since there is repeated production of similar types of components in precast construction, therefore, it results in faster execution, more productivity and economy. construction techniques & Materials for walls, roof & floor slab, doors & windows are as follows:

In Walls:- In the construction of walls, rammed earth, normal bricks, soil cement blocks, hollow clay blocks, dense concrete blocks, small, medium and room size panels etc of different sizes are used. However, bricks continue to be the backbone of the building industry. In actual construction, the number of the bricks or blocks that are broken into different sizes to fit into position at site is very large. Which results in wastage of material poor quality. Increasing the size of wall blocks will prove economical due to greater speed and less mortar consumption, which can be achieved by producing low density bigger size wall blocks using industrial wastes like blast furnace slag and fly ash.

i. Non erodable mud plaster: Erodable mud plaster can be made non erodable by the use of bitumen cutback emulsion containing mixture of hot bitumen and kerosene oil. The mixture is pugged along with mud mortar and wheat/ rice straw. This mortar is applied on mud wall surface in thickness of 12 mm.

ii. Fly –Ash sand lime bricks: Fly Ash reacts with lime at ordinary temperature and forms a compound possessing cementitious properties. After reactions between lime and fly ash, calcium silicate hydrates are produced which are responsible for the high strength of the compound. Bricks made by mixing lime and fly ash are therefore, chemically bonded bricks and are of good quality.

iii. Solid concrete and stone blocks: This technique is suitable in areas where stones and aggregates for the blocks are available locally at cheaper rates. Innovative techniques of solid blocks with both lean concrete and stones have been developed for walls. The gang-mould is developed for semi-mechanized faster production of the blocks. In the manual process, single block moulds are

used wherein the concrete is compacted with help of a plate vibrator.

In Floor and Roof: Traditional Cast-in-situ concrete roof involve the use of temporary Shuttering which adds to the cost of construction and time. Use of standardized and optimized roofing components where shuttering is avoided prove to be economical, fast and better in quality. Some of the prefabricated roofing/flooring components found suitable in many low-cost housing projects are:

1. Precast RC Planks.
2. Prefabricated Brick Panels.
3. Precast RC Channel Roofing
4. Precast Hollow Slabs

1. *Precast RC plank roofing system*: This system consists of precast RC planks supported over partially precast joist. RC planks are made with thickness partly varying between 3 cm and 6 cm.
2.

Fig. 1 Precast R.C. Planks

Fig.2 R.C. Planks laid over partially precast joists

3. *Prefabricated brick panel roofing system:*

(a) *Prefab brick panel*

Brick panel is made of first class bricks reinforced with two MS bars of 6 mm dia and joints filled with either 1:3 cement sand mortar or M-15 concrete.

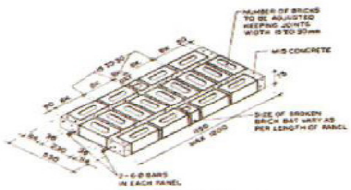

Fig. 3 Brick Panel

(b) *Partially precast joist*

It is a rectangular shaped joist 13 cm wide and 10 cm to 12.5 cm deep with stirrups projecting out so that the overall depth of joist with in-situ concrete becomes 21 cm to 23.5 cm, it is designed as composite Tee-beam with 3.5 cm thick flange.

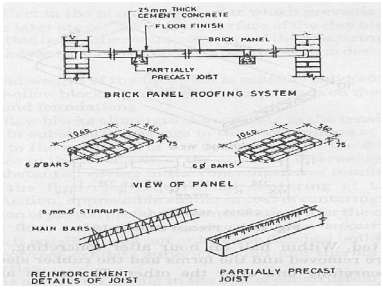

Fig. 4 Details of Precast Joist.

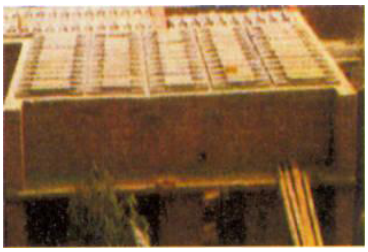

Fig.5 Precast R C Plank and Joist System

Structural design: The prefab brick panel for roof as well as for floor of residential buildings has two numbers 6 mm dia MS bars as reinforcement up to a span of 120 cms. The partially precast RC joist, is designed as simply supported Tee-beam with 3.5cm thick flange. The reinforcement in joist is provided as per design requirements depending upon the spacing and span of the joist.

4. *Precast RC channel roofing* Precast channels are trough shaped with the outer sides corrugated and grooved at the ends to provide shear key action and to transfer moments between adjacent units. Nominal width of units is 300 mm or 600 mm with overall depths of 130 mm to 200 mm. The lengths of the units are adjusted to suit the span. The flange thickness is 30 mm to 35 mm. A saving of 14% has been achieved in actual implementation in various projects.

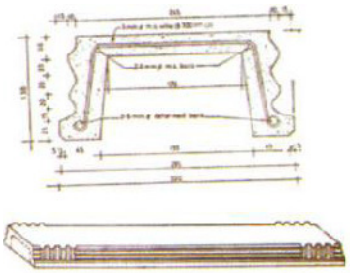

Fig. 6 RC Channel Unit System

5. *Precast hollow slabs roofing* Precast hollow slabs are panels in which voids are created by earthen kulars. without decreasing the stiffness or strength. These hollow slabs are lighter than solid slabs and thus save the cost of concrete, steel and the cost of walling and foundations too due to less weight. There is saving of about 30% in cost of concrete and an overall saving of about 23%.

Fig.7 Hollow Slabs Roofing System

Seismic strengthening arrangements of precast roofing systems IS-4326,1993 has given recommendations regarding strengthening measures for precast roofing techniques. The code recommends that for building category A, B and C based on seismic co-efficient, a tie beam is to be provided all round the floor or roof to bind together all the precast components to make it a diaphragm. The beams shall be to the full width of supporting wall less the bearing of precast components. The depth of the beam shall be equal to the depth of the precast components plus the thickness of structural deck concrete, whenever used over the components. Tie beams shall be provided on all longitudinal and cross walls. In category D, structural deck concrete of 35 mm thickness reinforced with 6 mm dia bars, 150 mm both ways and anchored into tie beams shall be provided. For economy, the deck concrete itself can serve as floor finish.

Materials used:- (BMTPC- Building Materials & Technology Promotion Council, Govt. of India) By and large, conventional building materials like burnt bricks, steel and cement are higher in cost, utilize large amount of non-renewable natural resources like energy, minerals, top soil, forest cover, etc,. The continued use of such conventional materials has adverse impact on economy and environment. Environment friendly materials and technologies with cost effectiveness are, therefore, required to be adopted for sustainable constructions which must fulfill some or more of the following criterion :-

- Not endanger bio-reserves and be non-polluting.
- Utilize locally available materials.
- Utilize local skills and manpower.
- Utilize renewable energy sources.
- Be accessible to people.
- Be low in monetary cost.

2. Result and Conclusion

Mass housing targets can be achieved by replacing the conventional methods of planning and executing building operation based on special and individual needs and accepting common denominator based on surveys, population needs and rational use of materials and resources. The essence lies in the systematic approach in building methodology and not necessarily particular construction type or design. The methodology for low cost housing has to be of intermediate type less sophisticated involving less capital investment.

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